

CLAIMS

1. A first-order modified, hydrogenated polymer comprising:

5 (1) a hydrogenated polymer obtained by hydrogenating at least one unhydrogenated polymer selected from the group consisting of (1-A) a polymer comprising conjugated diene monomer units and (1-B) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer (1-B) having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, and

10 (2) a functional group-containing first-order modifier group bonded to said hydrogenated polymer (1), wherein said functional group-containing first-order modifier group comprises at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group,

15 said first-order modified, hydrogenated polymer having the following characteristics (i) to (iv):

(i) a content of said vinyl aromatic hydrocarbon monomer units of from 0 to 60 % by weight, based on the weight of said hydrogenated polymer,

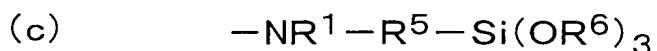
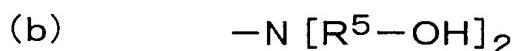
20 (ii) a vinyl aromatic hydrocarbon block ratio of

from 0 to less than 50 % by weight, wherein said vinyl aromatic hydrocarbon block ratio is defined as the percent by weight of the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer (1-B),

5 (iii) a weight average molecular weight of from 20,000 to 2,000,000, and

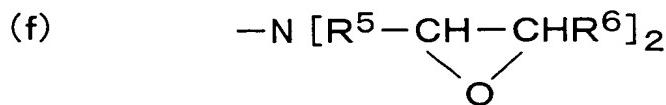
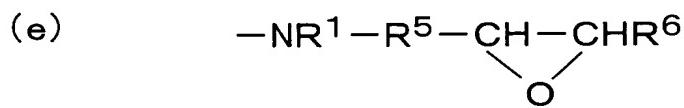
10 (iv) a hydrogenation ratio of more than 70 %, as measured with respect to the double bonds in said conjugated diene monomer units.

2. The first-order modified, hydrogenated polymer according to claim 1, wherein said functional group-containing first-order modifier group (2) comprises at least one functional group represented by a formula selected from the group consisting of the following formulae (a) to (m):

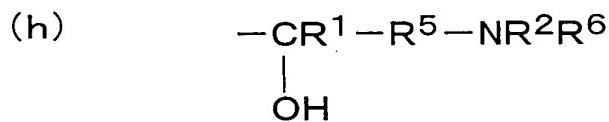
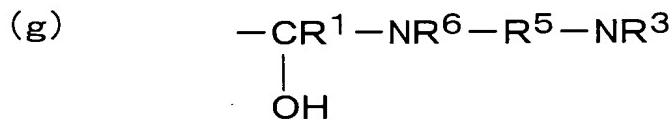




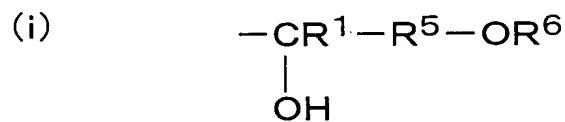
5



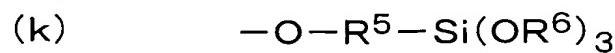
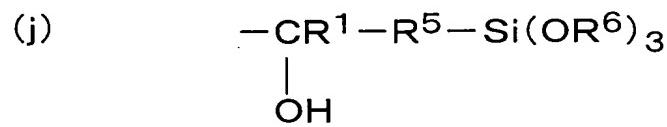
10



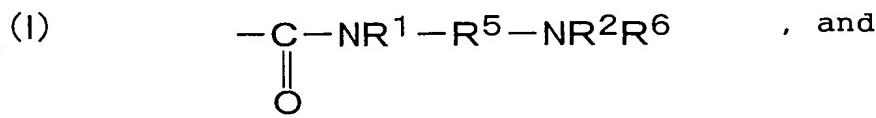
15

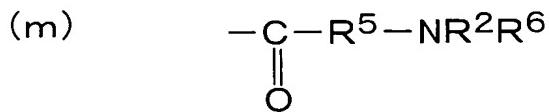


20



25





wherein, in the formulae (a) to (m):

5 N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

10 each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

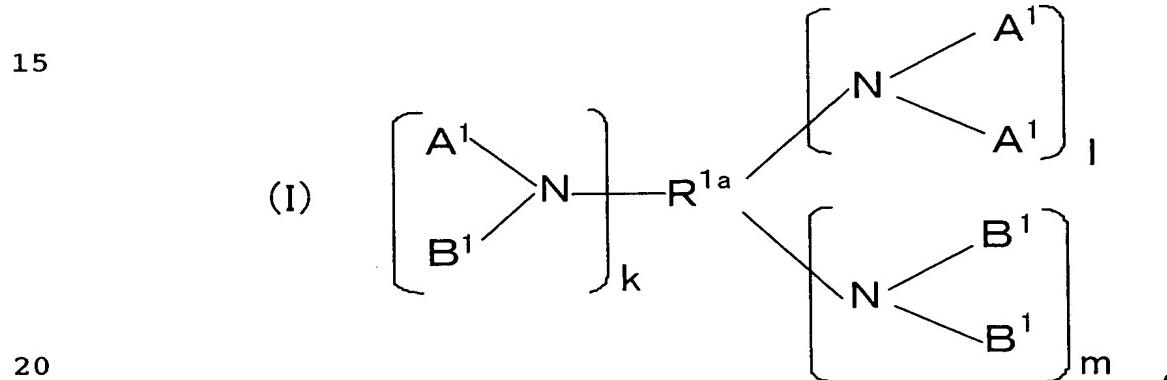
15 each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

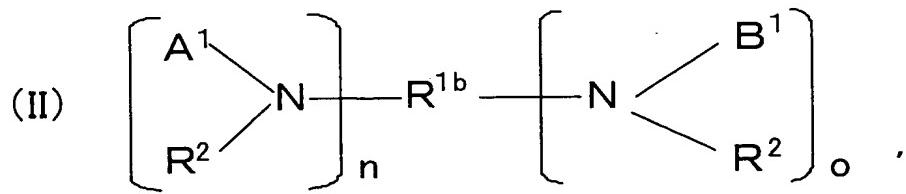
20 each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,

25 wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, in-

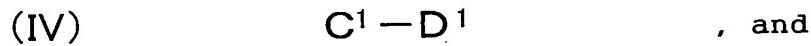
dependently has bonded thereto at least one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage other than a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

3. The first-order modified, hydrogenated polymer according to claim 1 or 2, which is represented by a formula selected from the group consisting of the following formulae (I) to (V):





5



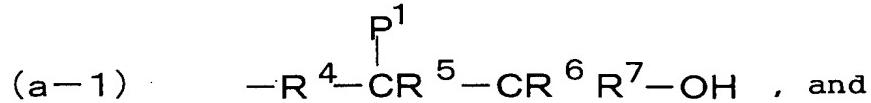
10



wherein:

$A^1$  represents a unit which is represented by any one of the following formulae (a-1) and (b-1):

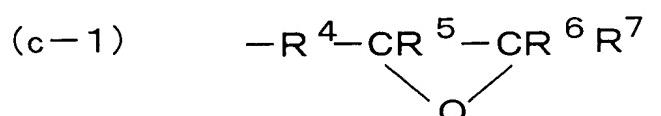
15



20

$B^1$  represents a unit which is represented by the following formula (c-1):

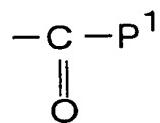
25



$C^1$  represents a unit which is represented by any one of the following formulae (d-1) and (e-1):

5

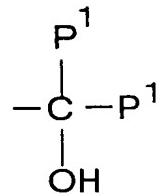
(d-1)



, and

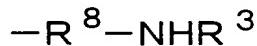
10

(e-1)



$D^1$  represents a unit which is represented by the following formula (f-1):

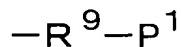
(f-1)



15

$E^1$  represents a unit which is represented by the following formula (g-1):

(g-1)

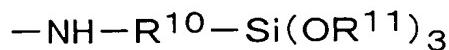


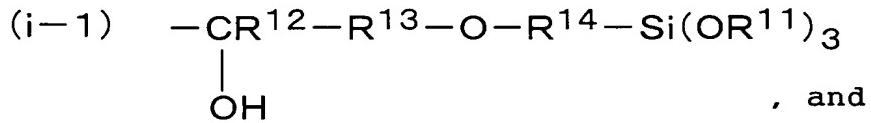
, and

$F^1$  represents a unit which is represented by any one of the following formulae (h-1) to (j-1):

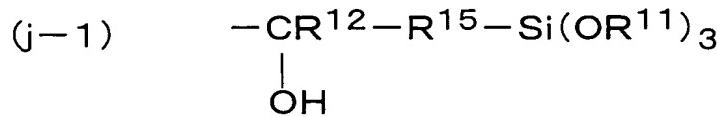
20

(h-1)





5



wherein, in the formulae (I) to (III) and  
 (a-1) to (j-1):

10

N represents a nitrogen atom, Si  
 represents a silicon atom, O represents  
 an oxygen atom, C represents a carbon  
 atom, and H represents a hydrogen atom,  
 p<sup>1</sup> represents said hydrogenated polymer  
 (1),

15

R<sup>1a</sup> represents a trivalent aliphatic  
 C<sub>1</sub>-C<sub>48</sub> hydrocarbon group,  
 each of R<sup>1b</sup>, R<sup>4</sup>, R<sup>8</sup> to R<sup>10</sup> and R<sup>13</sup> to R<sup>15</sup>  
 independently represents a C<sub>1</sub>-C<sub>48</sub> alkylene  
 group,

20

each of R<sup>2</sup>, R<sup>3</sup> and R<sup>11</sup> independently  
 represents a C<sub>1</sub>-C<sub>48</sub> alkyl group, a C<sub>6</sub>-C<sub>48</sub>  
 aryl group, an alkylaryl group comprised  
 of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, an aralkyl  
 group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub>  
 aryl, or a C<sub>3</sub>-C<sub>48</sub> cycloalkyl group,

25

wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>8</sup> to  
R<sup>10</sup> and R<sup>13</sup> to R<sup>15</sup> optionally, independently  
has at least one functional group selected  
from the group consisting of a hydroxyl  
group, an epoxy group, an amino group, a  
silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane  
group,

5

each of R<sup>5</sup> to R<sup>7</sup> and R<sup>12</sup> independently  
represents a hydrogen atom, a C<sub>1</sub>-C<sub>48</sub> alkyl  
group, a C<sub>6</sub>-C<sub>48</sub> aryl group, an alkyl aryl  
group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub>  
aryl, an aralkyl group comprised of C<sub>1</sub>-C<sub>48</sub>  
alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, or a C<sub>3</sub>-C<sub>48</sub> cyclo-  
alkyl group,

10

15

wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>2</sup> to R<sup>4</sup> and R<sup>8</sup>  
to R<sup>15</sup> optionally, independently has  
bonded thereto at least one atom selected  
from the group consisting of an oxygen  
atom, a nitrogen atom, a sulfur atom and  
a silicon atom, said at least one atom  
being present in a linkage other than a  
hydroxyl group, an epoxy group, an amino  
group, a silanol group and an alkoxy si-  
lane group, and

20

25

each of k, l, m and o is independently

an integer of 0 or more, provided that  
both k and l are not simultaneously 0,  
and n is an integer of 1 or more.

5       4. A filler-containing modified polymer composition  
comprising:

100 parts by weight of (A-1) the first-order modified,  
hydrogenated polymer of any one of claims 1 to 3,  
and

10       0.5 to 300 parts by weight of (B) a reinforcing  
filler.

15       5. The filler-containing modified polymer composition  
according to claim 4, which further comprises 0.01 to  
20 parts by weight of (C) a second-order modifier hav-  
ing a functional group which is reactive to said func-  
tional group of said modifier group of said first-order  
modified, hydrogenated polymer (A-1), wherein said sec-  
ond-order modifier (C) is at least one member selected  
20       from the group consisting of a functional monomer and a  
functional oligomer.

25       6. The filler-containing modified polymer composition  
according to claim 4 or 5, wherein said reinforcing  
filler (B) is at least one member selected from the

group consisting of a silica inorganic filler, a metal oxide, a metal hydroxide and carbon.

7. A crosslinked, filler-containing modified polymer composition obtained by subjecting the filler-containing modified polymer composition of any one of claims 4 to 6 to a crosslinking reaction in the presence of a vulcanizing agent.

10 8. A modified polymer composition comprising:  
1 to 99 parts by weight, relative to 100 parts by weight of the total of components (A-1) and (D), of (A-1) the first-order modified, hydrogenated polymer of any one of claims 1 to 3, and  
15 99 to 1 part by weight, relative to 100 parts by weight of the total of components (A-1) and (D), of (D) at least one polymer selected from the group consisting of a thermoplastic resin other than said first-order modified, hydrogenated polymer (A-1) and a rubbery polymer other than said first-order modified, hydrogenated polymer (A-1).

20 9. The modified polymer composition according to claim 8, which further comprises 0.01 to 20 parts by weight, relative to 100 parts by weight of the total of

components (A-1) and (D), of (C) a second-order modifier having a functional group which is reactive to said functional group of said modifier group of said first-order modified, hydrogenated polymer (A-1),

5 wherein said second-order modifier (C) is at least one member selected from the group consisting of a functional monomer and a functional oligomer.

10. The modified polymer composition according to  
claim 8 or 9, wherein said rubbery polymer in component  
(D) comprises at least one member selected from the  
group consisting of a conjugated diene polymer compris-  
ing conjugated diene monomer units, a random copolymer  
comprising conjugated diene monomer units and vinyl  
aromatic hydrocarbon monomer units, a block copolymer  
15 comprising conjugated diene monomer units and vinyl  
aromatic hydrocarbon monomer units, a non-diene polymer  
and a natural rubber,

20 said rubbery polymer being unhydrogenated or at  
least partially hydrogenated.

11. The modified polymer composition according to any  
one of claims 8 to 10, wherein said thermoplastic resin  
in component (D) is a functional group-containing ther-  
25 moplastic resin and said rubbery polymer in component

(D) is a functional group-containing rubbery polymer,  
wherein each of said functional group-containing ther-  
moplastic resin and rubbery polymer contains at least  
one functional group which is reactive to said func-  
tional group of said first-order modifier group of said  
first-order modified, hydrogenated polymer (A-1).

12. The modified polymer composition according to  
claim 11, wherein said functional group-containing  
thermoplastic resin comprises at least one member se-  
lected from the group consisting of a polyester resin,  
a polyamide resin, a polycarbonate resin, a polyure-  
thane resin, a polyphenylene ether resin and a polyoxy-  
ethylene resin each of which contains at least one  
functional group selected from the group consisting of  
an acid anhydride group, a carboxyl group, a hydroxyl  
group, an epoxy group, an amino group, a silanol group  
and an alkoxy silane group.

13. An adhesive composition comprising:  
100 parts by weight of (A-1) the first-order modi-  
fied, hydrogenated polymer of any one of claims 1 to 3,  
and  
20 to 400 parts by weight of (E) a tackifier.

14. The adhesive composition according to claim 13,  
which further comprises 0.01 to 20 parts by weight of  
(C) a second-order modifier having a functional group  
which is reactive to said functional group of said  
5 modifier group of said first-order modified, hydrogen-  
ated polymer (A-1), wherein said second-order modifier  
(C) is at least one member selected from the group con-  
sisting of a functional monomer and a functional oli-  
gomer.

10

15. An asphalt composition comprising:  
0.5 to 50 parts by weight of (A-1) the first-order  
modified, hydrogenated polymer of any one of claims 1  
to 3, and  
15 100 parts by weight of (F) an asphalt.

16. The asphalt composition according to claim 15,  
which further comprises 0.01 to 20 parts by weight of  
(C) a second-order modifier having a functional group  
20 which is reactive to said functional group of said  
modifier group of said first-order modified, hydrogen-  
ated polymer (A-1), wherein said second-order modifier  
(C) is at least one member selected from the group con-  
sisting of a functional monomer and a functional oli-  
25 gomer.

17. A styrene resin composition obtained by subjecting a raw material mixture to radical polymerization, said raw material mixture comprising:

5           2 to 30 parts by weight, relative to 100 parts by weight of the total of components (A-1) and (G), of (A-1) the first-order modified, hydrogenated polymer of any one of claims 1 to 3, and

10          98 to 70 parts by weight, relative to 100 parts by weight of the total of components (A-1) and (G), of (G) a vinyl aromatic hydrocarbon monomer or a mixture of a vinyl aromatic hydrocarbon monomer and a comonomer copolymerizable with said vinyl aromatic hydrocarbon monomer.

15

18. The styrene resin composition according to claim 17, wherein said raw material mixture further comprises 0.01 to 20 parts by weight, relative to 100 parts by weight of the total of components (A-1) and (G), of (C) 20 a second-order modifier having a functional group which is reactive to said functional group of said modifier group of said first-order modified, hydrogenated polymer (A-1), wherein said second-order modifier (C) is at least one member selected from the group consisting of 25 a functional monomer and a functional oligomer.

19. A method for producing the styrene resin composition of claim 17 or 18, comprising:

(1) providing a raw material mixture comprising  
5 (A-1) the first-order modified, hydrogenated polymer of any one of claims 1 to 3, (G) a vinyl aromatic hydrocarbon monomer or a mixture of a vinyl aromatic hydrocarbon monomer and a comonomer copolymerizable with said vinyl aromatic hydrocarbon monomer, and optionally  
10 at least one member selected from the group consisting of (C) a second-order modifier and (B) a reinforcing filler, and

(2) subjecting said raw material mixture to radical polymerization,

15 thereby obtaining a styrene resin composition.

20. A second-order modified polymer comprising:

(β) a base polymer, and  
20 (δ) a functional group-containing modifier group bonded to said base polymer (β),  
wherein said second-order modified polymer is obtained by reacting a second-order modifier with a first-order modified polymer comprising (β) a base polymer and (γ) a functional group-containing first-order modifier group bonded to said base polymer (β) to

thereby form ( $\delta$ ) a functional group-containing modifier group, wherein said second-order modifier has a functional group which is reactive to said functional group of said first-order modifier group ( $\gamma$ ) of said first-order modified polymer, and wherein said second-order modifier is used in an amount of 0.3 to 10 moles, relative to one equivalent of the functional group of said first-order modifier group ( $\gamma$ ) of said first-order modified polymer,

10           said second-order modifier being at least one member selected from the group consisting of a functional monomer and a functional oligomer,

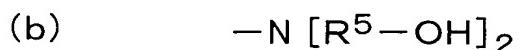
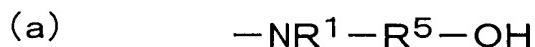
15           wherein said base polymer ( $\beta$ ) of said first-order modified polymer is unhydrogenated or at least partially hydrogenated and is at least one member selected from the group consisting of the following polymers ( $\beta$ -1) to ( $\beta$ -3):

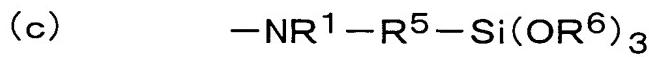
( $\beta$ -1) a conjugated diene polymer comprising conjugated diene monomer units,

20           ( $\beta$ -2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein said copolymer has a vinyl

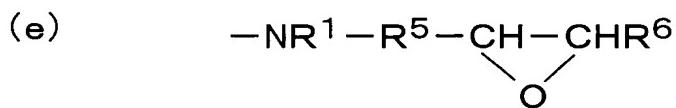
aromatic hydrocarbon block ratio of from 0  
to less than 50 % by weight, said vinyl aro-  
matic hydrocarbon block ratio being defined  
as the percent by weight of the vinyl aro-  
matic hydrocarbon monomer units contained in  
said at least one polymer block (H) of said  
vinyl aromatic hydrocarbon monomer units,  
based on the total weight of vinyl aromatic  
hydrocarbon monomer units contained in said  
copolymer as in the unhydrogenated state,  
and

(β-3) a vinyl aromatic hydrocarbon poly-  
mer comprising vinyl aromatic hydrocarbon  
monomer units, and  
wherein said functional group-containing  
first-order modifier group ( $\gamma$ ) of said first-order  
modified polymer comprises at least one functional  
group represented by a formula selected from the  
group consisting of the following formulae (a) to  
(m):

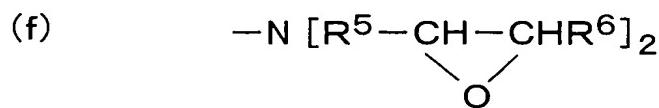




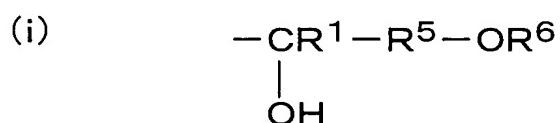
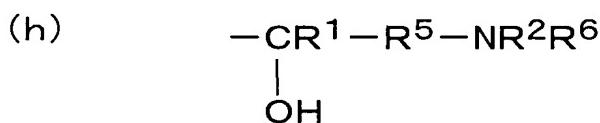
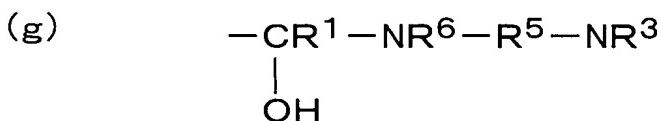
5



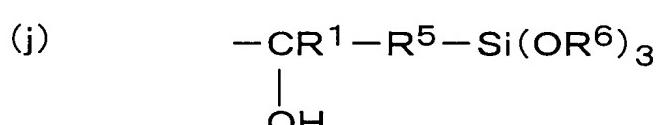
10



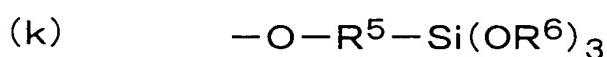
15



20



25



(I)  $\begin{array}{c} -C-NR^1-R^5-NR^2R^6 \\ || \\ O \end{array}$ , and

5

(m)  $\begin{array}{c} -C-R^5-NR^2R^6 \\ || \\ O \end{array}$ 

wherein, in the formulae (a) to (m):

10

N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

15

each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

20

each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

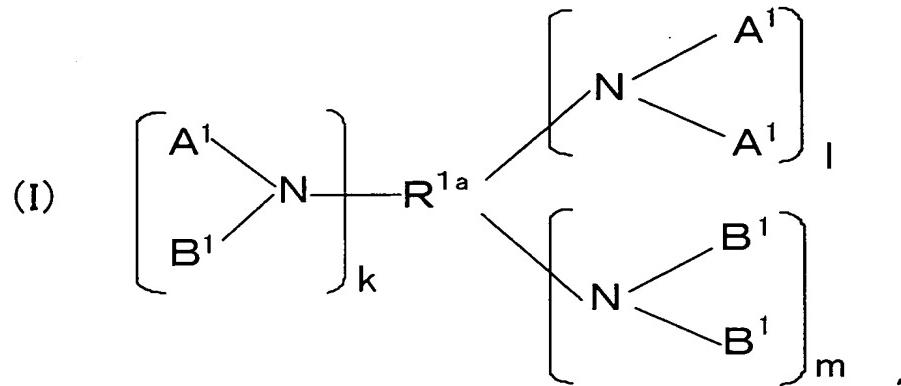
25

each R<sup>6</sup> independently represents a  
hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,  
wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, in-  
dependently has bonded thereto at least  
5 one atom selected from the group consist-  
ing of an oxygen atom, a nitrogen atom, a  
sulfur atom and a silicon atom, said at  
least one atom being present in a linkage  
other than a hydroxyl group, an epoxy  
10 group, an amino group, a silanol group and  
an alkoxy silane group.

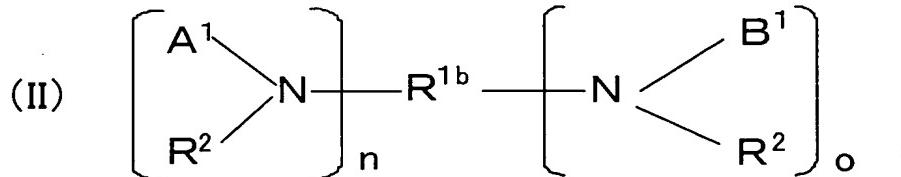
21. The second-order modified polymer according to  
claim 20, wherein said first-order modified polymer is  
represented by a formula selected from the group con-  
sisting of the following formulae (I) to (V):

5

10



15

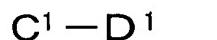


(III)



20

(IV)



, and

(V)



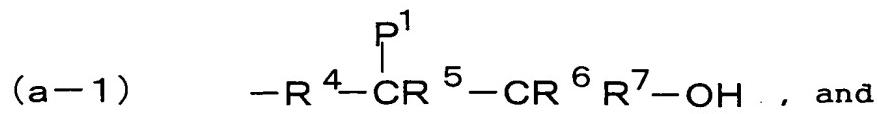
wherein:

25

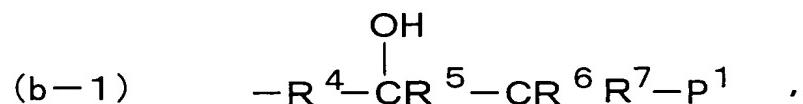
$A^1$  represents a unit which is represented by any

one of the following formulae (a-1) and (b-1):

5

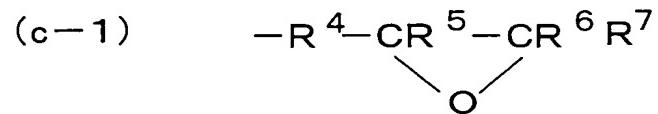


10



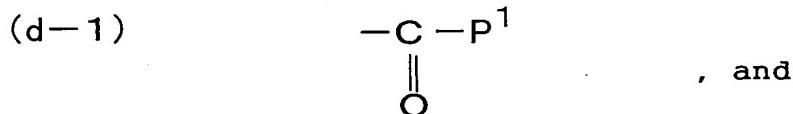
$\text{B}^1$  represents a unit which is represented by the  
following formula (c-1):

15



$\text{C}^1$  represents a unit which is represented by any  
one of the following formulae (d-1) and (e-1):

20



25



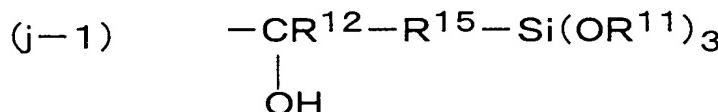
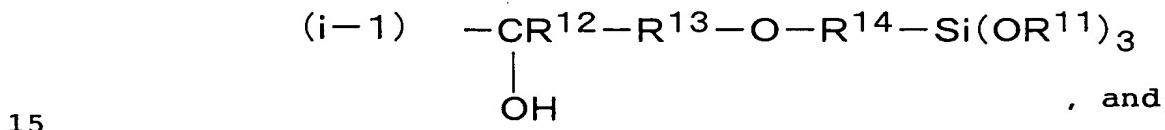
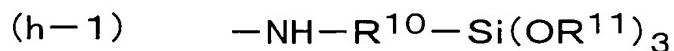
$\text{D}^1$  represents a unit which is represented by the  
following formula (f-1):



5             $E^1$  represents a unit which is represented by the  
following formula (g-1):



10           $F^1$  represents a unit which is represented by any  
one of the following formulae (h-1) to (j-1):



20          wherein, in the formulae (I) to (III) and  
(a-1) to (j-1):

N represents a nitrogen atom, Si  
represents a silicon atom, O represents  
an oxygen atom, C represents a carbon  
atom, and H represents a hydrogen atom,

P<sup>1</sup> represents said base polymer,  
R<sup>1a</sup> represents a trivalent aliphatic  
C<sub>1</sub>-C<sub>48</sub> hydrocarbon group,  
each of R<sup>1b</sup>, R<sup>4</sup>, R<sup>8</sup> to R<sup>10</sup> and R<sup>13</sup> to R<sup>15</sup>  
5 independently represents a C<sub>1</sub>-C<sub>48</sub>  
alkylene group,  
each of R<sup>2</sup>, R<sup>3</sup> and R<sup>11</sup> independently  
represents a C<sub>1</sub>-C<sub>48</sub> alkyl group, a C<sub>6</sub>-C<sub>48</sub>  
aryl group, an alkylaryl group comprised  
10 of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, an  
aralkyl group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl  
and C<sub>6</sub>-C<sub>48</sub> aryl, or a C<sub>3</sub>-C<sub>48</sub> cycloalkyl  
group,  
wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>8</sup> to  
15 R<sup>10</sup> and R<sup>13</sup> to R<sup>15</sup> optionally, independ-  
ently has at least one functional group  
selected from the group consisting of a  
hydroxyl group, an epoxy group, an amino  
group, a silanol group and a C<sub>1</sub>-C<sub>24</sub>  
20 alkoxysilane group,  
each of R<sup>5</sup> to R<sup>7</sup> and R<sup>12</sup> independently  
represents a hydrogen atom, a C<sub>1</sub>-C<sub>48</sub>  
alkyl group, a C<sub>6</sub>-C<sub>48</sub> aryl group, an  
alkylaryl group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl  
25 and C<sub>6</sub>-C<sub>48</sub> aryl, an aralkyl group com-

prised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, or  
a C<sub>3</sub>-C<sub>48</sub> cycloalkyl group,

wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>2</sup> to R<sup>4</sup> and  
R<sup>8</sup> to R<sup>15</sup> optionally, independently has  
bonded thereto at least one atom se-  
lected from the group consisting of an  
oxygen atom, a nitrogen atom, a sulfur  
atom and a silicon atom, said at least  
one atom being present in a linkage  
other than a hydroxyl group, an epoxy  
group, an amino group, a silanol group  
and an alkoxy silane group, and  
each of k, l, m and o is independ-  
ently an integer of 0 or more, provided  
that both k and l are not simultaneously  
0, and n is an integer of 1 or more.

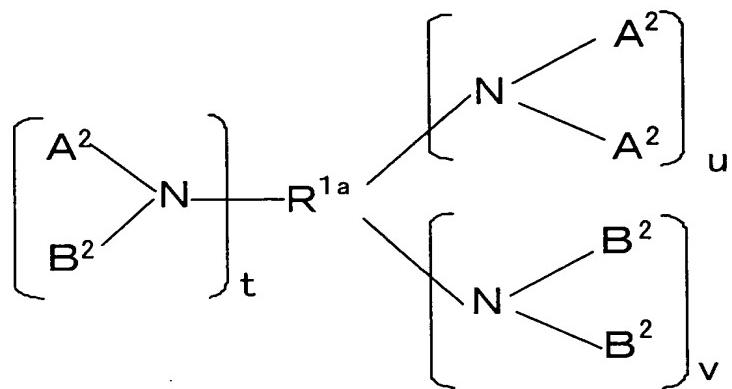
22. The second-order modified polymer according to  
claim 20 or 21, wherein each of said functional monomer  
and said functional oligomer has at least one func-  
tional group selected from the group consisting of a  
hydroxyl group, an amino group, a carboxyl group, an  
acid anhydride group, an isocyanate group, an epoxy  
group, a silanol group and an alkoxy silane group.

23. The second-order modified polymer according to any one of claims 20 to 22, which is represented by a formula selected from the group consisting of the following formulae (VI) to (X):

5

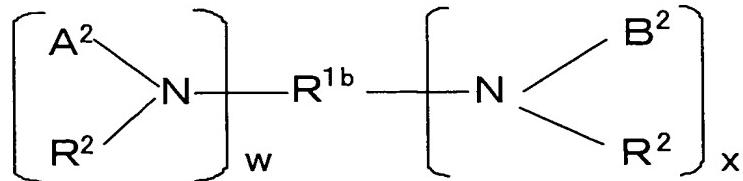
10

(VI)



15

(VII)



20

(VIII)

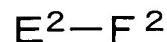


(IX)



, and

(X)

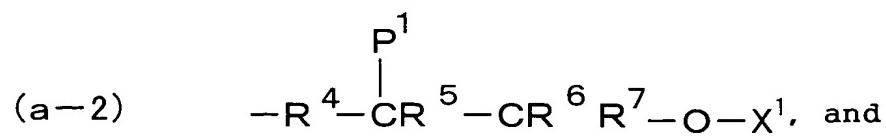


25

wherein:

$A^2$  represents a unit which is represented by any one of the following formulae (a-2) and (b-2):

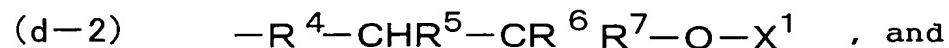
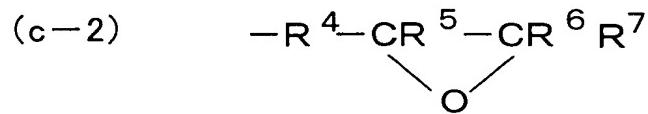
5



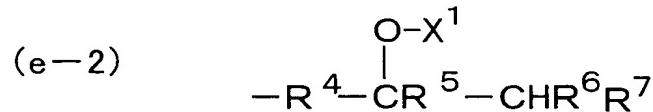
10

$B^2$  represents a unit which is represented by any one of the following formulae (c-2) to (e-2):

15



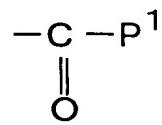
20



25

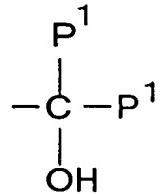
$C^2$  represents a unit which is represented by any one of the following formulae (f-2) to (h-2):

(f-2)



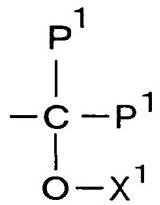
5

(g-2)



10

(h-2)



$D^2$  represents a unit which is represented by the following formula (i-2):

15

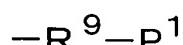
(i-2)



$E^2$  represents a unit which is represented by the following formula (j-2):

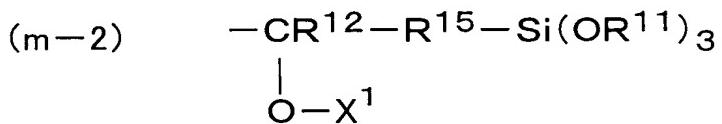
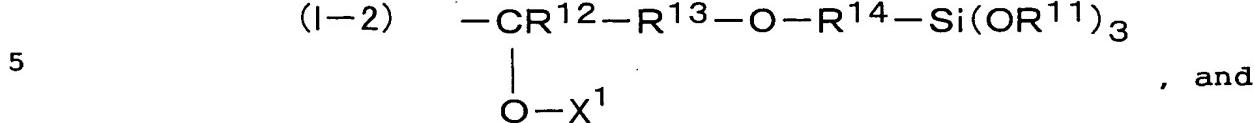
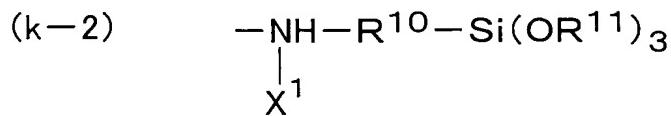
20

(j-2)



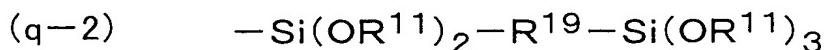
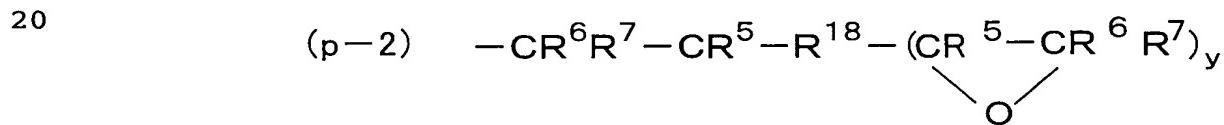
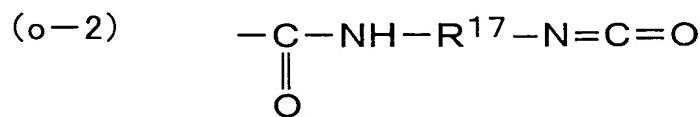
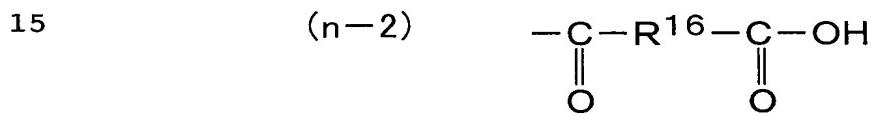
, and

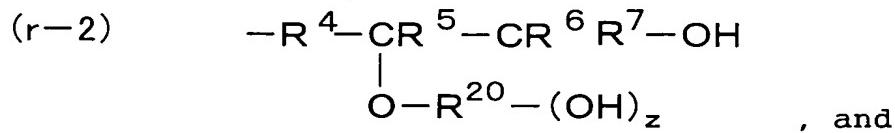
$F^2$  represents a unit which is represented by any one of the following formulae (k-2) to (m-2):



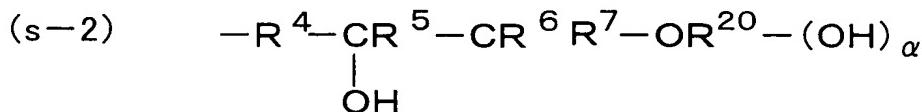
wherein:

$\text{X}^1$  represents a unit which is represented by any one of the following formulae (n-2) to (s-2):





5



wherein, in the formulae (VI) to (VIII)  
10 and (a-2) to (s-2):

N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

15 P<sup>1</sup> represents the base polymer,

R<sup>1a</sup> represents a trivalent aliphatic C<sub>1</sub>-C<sub>48</sub> hydrocarbon group,

each of R<sup>1b</sup>, R<sup>4</sup>, R<sup>8</sup> to R<sup>10</sup> and R<sup>13</sup> to R<sup>20</sup>  
20 independently represents a C<sub>1</sub>-C<sub>48</sub> alkylene group,

each of R<sup>2</sup>, R<sup>3</sup> and R<sup>11</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> alkyl group, a C<sub>6</sub>-C<sub>48</sub> aryl group, an alkylaryl group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, an aralkyl group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub>

25

aryl, or a C<sub>3</sub>-C<sub>48</sub> cycloalkyl group,

wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>8</sup> to  
R<sup>10</sup>, R<sup>13</sup> to R<sup>15</sup> and R<sup>17</sup> to R<sup>20</sup> optionally,  
independently has at least one functional  
group selected from the group consisting  
of a hydroxyl group, an epoxy group, an  
amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub>  
alkoxysilane group,

5

each of R<sup>5</sup> to R<sup>7</sup> and R<sup>12</sup> independently  
represents a hydrogen atom, a C<sub>1</sub>-C<sub>48</sub> alkyl  
group, a C<sub>6</sub>-C<sub>48</sub> aryl group, an alkylaryl  
group comprised of C<sub>1</sub>-C<sub>48</sub> alkyl and C<sub>6</sub>-C<sub>48</sub>  
aryl, an aralkyl group comprised of C<sub>1</sub>-C<sub>48</sub>  
alkyl and C<sub>6</sub>-C<sub>48</sub> aryl, or a C<sub>3</sub>-C<sub>48</sub> cyclo-  
alkyl group,

10

wherein each of R<sup>1a</sup>, R<sup>1b</sup>, R<sup>2</sup> to R<sup>4</sup> and R<sup>8</sup>  
to R<sup>20</sup> optionally, independently has bonded  
thereto at least one atom selected from  
the group consisting of an oxygen atom, a  
nitrogen atom, a sulfur atom, and a sili-  
con atom, said at least one atom being  
present in a linkage other than a hydroxyl  
group, an epoxy group, an amino group, a  
silanol group and an alkoxysilane group,  
and

20

25

5

each of t, u, v and x is independently an integer of 0 or more, provided that both t and u are not simultaneously 0, and each of w, y, z and α is independently an integer of 1 or more.

24. A method for producing the second-order modified polymer of any one of claims 20 to 23, comprising:

10 (1) providing a first-order modified polymer comprising:

(β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at least one member selected from the group consisting of the following polymers (β-1) to (β-3):

15 (β-1) a conjugated diene polymer comprising conjugated diene monomer units,

(β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein said copolymer has a vinyl aromatic hydrocarbon block ratio of from 0 to less than 50 % by weight, said vinyl aromatic hydrocarbon block ratio being defined as the percent by weight of

the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer as in the unhydrogenated state, and

5

(β-3) a vinyl aromatic hydrocarbon polymer comprising vinyl aromatic hydrocarbon monomer units, and

10

(γ) a functional group-containing first-order modifier group bonded to said base polymer (β), wherein said first-order modified polymer is produced by a process in which a base polymer having a living terminal is produced by a living anionic polymerization using an organolithium compound as a polymerization catalyst, and a functional group-containing first-order modifier is addition-bonded to said living terminal of said base polymer to obtain a first-order modified polymer, optionally followed by partial or complete hydrogenation of the obtained first-order modified polymer, and

15

20

25

(2) reacting a second-order modifier with said first-order modified polymer to thereby form (δ) a

functional group-containing modifier group, wherein  
said second-order modifier has a functional group which  
is reactive to said functional group of said first  
-order modifier group ( $\gamma$ ) of said first-order modified  
5 polymer, and wherein said second-order modifier is used  
in an amount of 0.3 to 10 moles, relative to one  
equivalent of said functional group of said first-order  
modifier group ( $\gamma$ ) of said first-order modified polymer,  
thereby obtaining a second-order modified polymer,  
10 wherein said functional group-containing  
first-order modifier group ( $\gamma$ ) of said first-  
order modified polymer comprises at least one  
functional group represented by a formula se-  
lected from the group consisting of the follow-  
15 ing formulae (a) to (m):

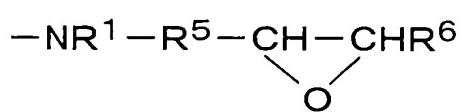
(a)  $-NR^1-R^5-OH$

(b)  $-N[R^5-OH]_2$

20 (c)  $-NR^1-R^5-Si(OR^6)_3$

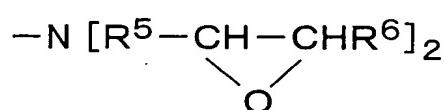
(d)  $-N[R^5-Si(OR^6)_3]_2$

(e)



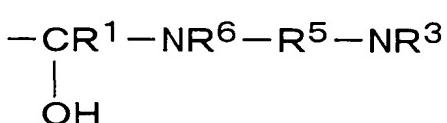
5

(f)



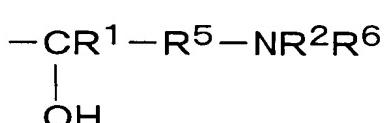
10

(g)



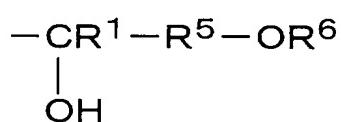
15

(h)

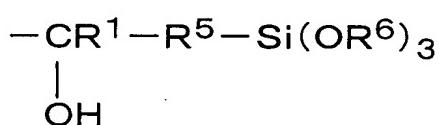


20

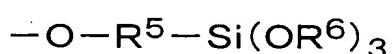
(i)



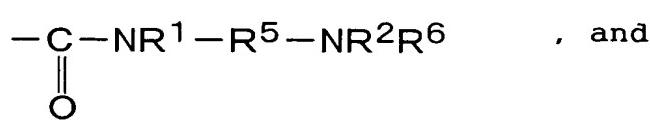
(j)

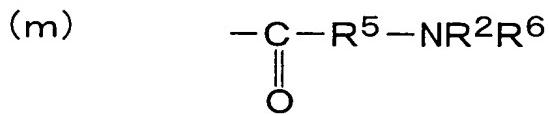


(k)



(l)





wherein, in the formulae (a) to (m):

5 N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

10 each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

15 each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

20 each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,

25 wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, in-

dependently has bonded thereto at least  
one atom selected from the group consist-  
ing of an oxygen atom, a nitrogen atom, a  
sulfur atom and a silicon atom, said at  
5 least one atom being present in a linkage  
other than a hydroxyl group, an epoxy  
group, an amino group, a silanol group and  
an alkoxy silane group.

10 25. A filler-containing modified polymer composition  
comprising:

100 parts by weight of (A-2) the second-order  
modified polymer of any one of claims 20 to 23,  
0.5 to 300 parts by weight of (B) a reinforcing  
15 filler.

20 26. The filler-containing modified polymer composition  
according to claim 25, wherein said reinforcing filler  
(B) is at least one member selected from the group con-  
sisting of a silica inorganic filler, a metal oxide, a  
metal hydroxide and carbon.

25 27. A crosslinked, filler-containing modified polymer  
composition obtained by subjecting the filler  
-containing modified polymer composition of claim 25 or

26 to a crosslinking reaction in the presence of a vulcanizing agent.

28. A modified polymer composition comprising:

5        1 to 99 parts by weight, relative to 100 parts by weight of the total of components (A-2) and (D), of (A-2) the second-order modified polymer of any one of claims 20 to 23, and

10      99 to 1 part by weight, relative to 100 parts by weight of the total of components (A-2) and (D), of (D) at least one polymer selected from the group consisting of a thermoplastic resin other than said second-order modified polymer (A-2) and a rubbery polymer other than said second-order modified polymer (A-2).

15

29. The modified polymer composition according to claim 28, wherein said thermoplastic resin in component (D) comprises at least one member selected from the group consisting of a polyester resin, a polyamide resin, a polycarbonate resin, a polyurethane resin, a polyphenylene ether resin and a polyoxymethylene resin each of which contains at least one functional group selected from the group consisting of an acid anhydride group, a carboxyl group, a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy-

25

silane group.

30. A crosslinked, modified polymer composition obtained by subjecting the modified polymer composition of any one of claim 28 or 29 to melt-kneading in the presence of a vulcanizing agent.

5  
31. An adhesive composition comprising:  
100 parts by weight of (A-2) the second-order modified polymer of any one of claims 20 to 23, and  
10 20 to 400 parts by weight of (E) a tackifier.

32. An asphalt composition comprising:  
15 0.5 to 50 parts by weight of (A-2) the second-order modified polymer of any one of claims 20 to 23, and  
and  
100 parts by weight of (F) an asphalt.

33. A styrene resin composition obtained by subjecting 20 a raw material mixture to radical polymerization, said raw material mixture comprising:  
25 2 to 30 parts by weight, relative to 100 parts by weight of the total of components (A-2) and (G), of (A-2) the second-order modified polymer of any one of claims 20 to 23, and

98 to 70 parts by weight, relative to 100 parts by weight of the total of components (A-2) and (G), of (G) a vinyl aromatic hydrocarbon monomer or a mixture of a vinyl aromatic hydrocarbon monomer and a comonomer co-polymerizable with said vinyl aromatic hydrocarbon monomer.

5           34. The styrene resin composition according to claim  
33, wherein said raw material mixture further comprises  
10          0.5 to 300 parts by weight, relative to 100 parts by  
weight of component (A-2), of (B) a reinforcing filler.

15          35. The styrene resin composition according to claim  
34, wherein said reinforcing filler (B) is at least one  
member selected from the group consisting of a silica  
inorganic filler, a metal oxide, a metal hydroxide and  
carbon.

36. A filler-containing modified polymer composition comprising:

100 parts by weight of (A-3) a first-order modified polymer comprising:

5 (β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at least one member selected from the group consisting of the following polymers (β-1) to (β-3):

10 (β-1) a conjugated diene polymer comprising conjugated diene monomer units,

15 (β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein said copolymer has a vinyl aromatic hydrocarbon block ratio of from 0 to less than 50 % by weight, said vinyl aromatic hydrocarbon block ratio being defined as the percent by weight of the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer as in the unhydrogenated state,

20  
25

and

(β-3) a vinyl aromatic hydrocarbon polymer comprising vinyl aromatic hydrocarbon monomer units, and

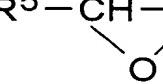
5 (γ) a functional group-containing first-order modifier group bonded to said base polymer (β), 0.5 to 300 parts by weight of (B) a reinforcing filler, and

10 0.01 to 20 parts by weight of (C) a second-order modifier having a functional group which is reactive to said functional group of said first-order modifier group (γ) of said first-order modified polymer (A-3), wherein said second-order modifier (C) is at least one member selected from the group consisting of a functional monomer and a functional oligomer,

15 wherein said functional group-containing first-order modifier group (γ) of said first-order modified polymer (A-3) comprises at least one functional group represented by a formula selected from the group consisting of the following formulae (a) to (m):

(a)  $-NR^1-R^5-OH$

25 (b)  $-N[R^5-OH]_2$

- (c)  $-\text{NR}^1-\text{R}^5-\text{Si}(\text{OR}^6)_3$
- (d)  $-\text{N}[\text{R}^5-\text{Si}(\text{OR}^6)_3]_2$
- (e)  $-\text{NR}^1-\text{R}^5-\text{CH}-\text{CHR}^6$   

- (f)  $-\text{N}[\text{R}^5-\text{CH}-\text{CHR}^6]_2$   

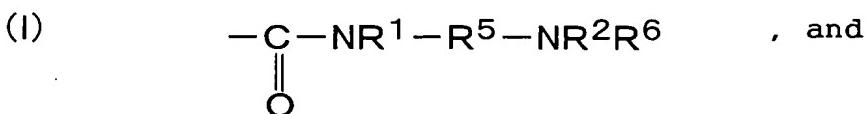
- (g)  $-\text{CR}^1-\text{NR}^6-\text{R}^5-\text{NR}^3$   

- (h)  $-\text{CR}^1-\text{R}^5-\text{NR}^2\text{R}^6$   

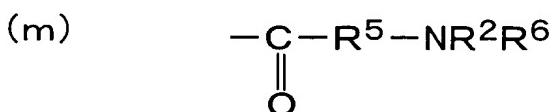
- (i)  $-\text{CR}^1-\text{R}^5-\text{OR}^6$   

- (j)  $-\text{CR}^1-\text{R}^5-\text{Si}(\text{OR}^6)_3$   

- (k)  $-\text{O}-\text{R}^5-\text{Si}(\text{OR}^6)_3$



5



wherein, in the formulae (a) to (m):

10

N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

15

each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

20

each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

25

each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,  
wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, independently has bonded thereto at least  
5 one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage other than a hydroxyl group, an epoxy group, an amino group, a silanol group and  
10 an alkoxy silane group.

37. The filler-containing modified polymer composition according to claim 36, wherein said reinforcing filler  
15 (B) is at least one member selected from the group consisting of a silica inorganic filler, a metal oxide, a metal hydroxide and carbon.

38. A crosslinked, filler-containing modified polymer composition obtained by subjecting the filler  
20 -containing modified polymer composition of claim 36 or 37 to a crosslinking reaction in the presence of a vulcanizing agent.

25 39. A modified polymer composition comprising:

1 to 99 parts by weight, relative to 100 parts by weight of the total of components (A-3) and (D), of (A-3) a first-order modified polymer comprising:

5 (β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at least one member selected from the group consisting of the following polymers (β-1) to (β-3):

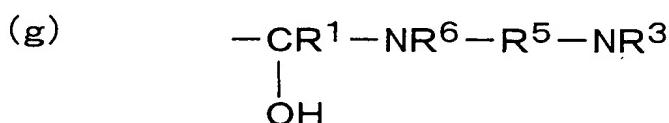
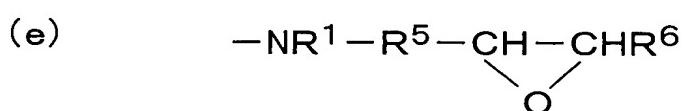
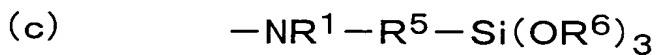
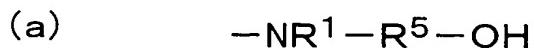
(β-1) a conjugated diene polymer comprising conjugated diene monomer units,

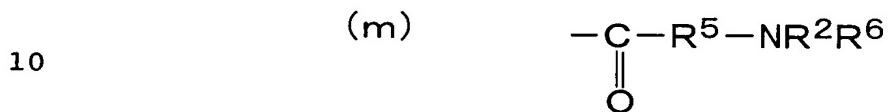
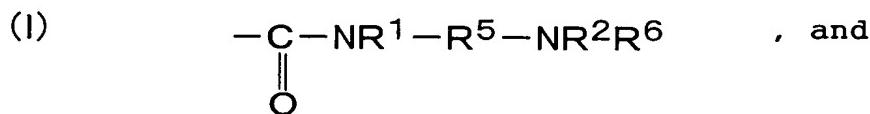
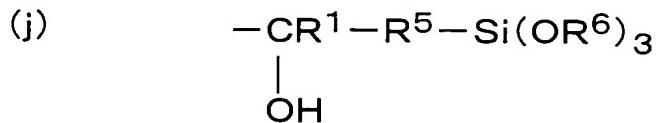
10 (β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein said copolymer has a vinyl aromatic hydrocarbon block ratio of from 0 to less than 50 % by weight, said vinyl aromatic hydrocarbon block ratio being defined as the percent by weight of the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer as in the unhydrogenated state,  
15  
20  
25 and

( $\beta$ -3) a vinyl aromatic hydrocarbon polymer comprising vinyl aromatic hydrocarbon monomer units, and

( $\gamma$ ) a functional group-containing first-order modifier group bonded to said base polymer ( $\beta$ ),  
5 99 to 1 part by weight, relative to 100 parts by weight of the total of components (A-3) and (D), of (D) at least one polymer selected from the group consisting of a thermoplastic resin other than said first-order  
10 modified polymer (A-3) and a rubbery polymer other than said first-order modified polymer (A-3), and  
0.01 to 20 parts by weight, relative to 100 parts by weight of the total of components (A-3) and (D), of  
(C) a second-order modifier having a functional group  
15 which is reactive to said functional group of said first-order modifier group ( $\gamma$ ) of said first-order modified polymer (A-3), wherein said second-order modifier (C) is at least one member selected from the group consisting of a functional monomer and a functional  
20 oligomer,  
wherein said functional group-containing  
first-order modifier group ( $\gamma$ ) of said first  
-order modified polymer (A-3) comprises at  
least one functional group represented by a  
25 formula selected from the group consisting of

the following formulae (a) to (m):





wherein, in the formulae (a) to (m):

N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxysilane group,

20 each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, inde-

pendently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

5

each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,

10

wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, independently has bonded thereto at least one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage other than a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

15

40. The modified polymer composition according to claim 39, wherein said thermoplastic resin in component (D) comprises at least one member selected from the group consisting of a polyester resin, a polyamide resin, a polycarbonate resin, a polyurethane resin, a polyphenylene ether resin and a polyoxymethylene resin each of which contains at least one functional group selected from the group consisting of an acid anhydride

25

group, a carboxyl group, a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy-silane group.

5       41. A crosslinked, modified polymer composition obtained by subjecting the modified polymer composition of claim 39 or 40 to melt-kneading in the presence of a vulcanizing agent.

10      42. An adhesive composition comprising:  
          100 parts by weight of (A-3) a first-order modified polymer comprising:

15      (β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at least one member selected from the group consisting of the following polymers (β-1) to (β-3):

          (β-1) a conjugated diene polymer comprising conjugated diene monomer units,

20      (β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein said copolymer has a vinyl aromatic hydrocarbon block ratio of from 0 to less than 50 % by  
25

weight, said vinyl aromatic hydrocarbon block ratio being defined as the percent by weight of the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer as in the unhydrogenated state, and

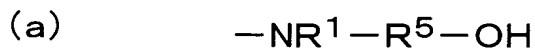
10 (β-3) a vinyl aromatic hydrocarbon polymer comprising vinyl aromatic hydrocarbon monomer units, and

(γ) a functional group-containing first-order modifier group bonded to said base polymer (β), 15 20 to 400 parts by weight of (E) a tackifier, and 0.01 to 20 parts by weight of (C) a second-order modifier having a functional group which is reactive to said functional group of said first-order modifier group (γ) of said first-order modified polymer (A-3), 20 wherein said second-order modifier (C) is at least one member selected from the group consisting of a functional monomer and a functional oligomer,

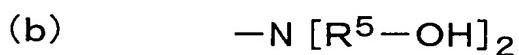
wherein said functional group-containing first-order modifier group (γ) of said first-order modified polymer (A-3) comprises at least 25

one functional group represented by a formula selected from the group consisting of the following formulae (a) to (m):

5



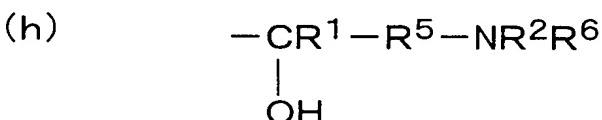
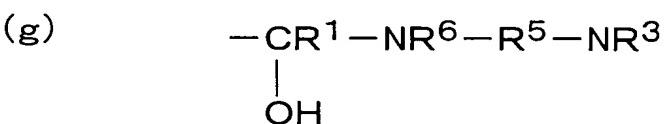
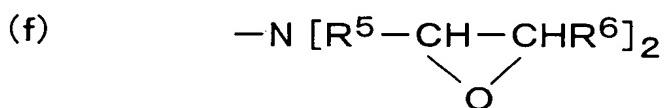
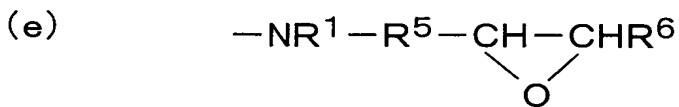
10

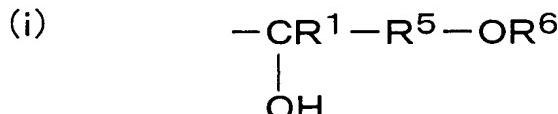


15

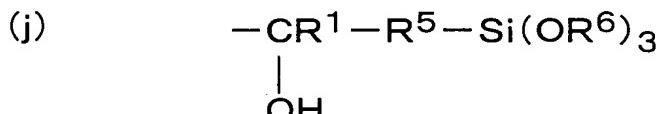


20

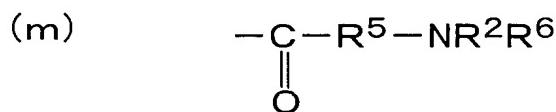
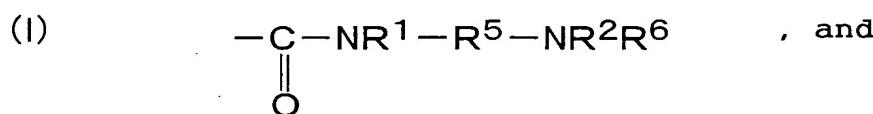




5



10



15

wherein, in the formulae (a) to (m):

N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

20

each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol

25

group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

5

each R<sup>6</sup> independently represents a

10

hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,

wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, independently has bonded thereto at least one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage other than a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

15

20

43. An asphalt composition comprising:

0.5 to 50 parts by weight of (A-3) a first-order modified polymer comprising:

25

(β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at

least one member selected from the group consisting of the following polymers (β-1) to (β-3):

(β-1) a conjugated diene polymer comprising conjugated diene monomer units,

5 (β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl aromatic hydrocarbon monomer units, wherein  
10 said copolymer has a vinyl aromatic hydrocarbon block ratio of from 0 to less than 50 % by weight, said vinyl aromatic hydrocarbon block ratio being defined as the percent by weight of the vinyl aromatic hydrocarbon monomer units contained in said at least one polymer block  
15 (H) of said vinyl aromatic hydrocarbon monomer units, based on the total weight of vinyl aromatic hydrocarbon monomer units contained in said copolymer as in the unhydrogenated state,  
20 and

(β-3) a vinyl aromatic hydrocarbon polymer comprising vinyl aromatic hydrocarbon monomer units, and

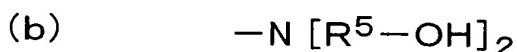
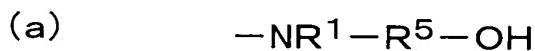
25 (γ) a functional group-containing first-order modifier group bonded to said base polymer (β),

100 parts by weight of (F) an asphalt, and  
0.01 to 20 parts by weight of (C) a second-order  
modifier having a functional group which is reactive to  
said functional group of said first-order modifier

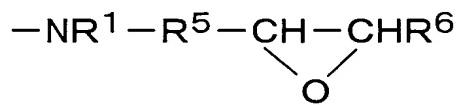
5 group ( $\gamma$ ) of said first-order modified polymer (A-3),  
wherein said second-order modifier (C) is at least one  
member selected from the group consisting of a func-  
tional monomer and a functional oligomer,

10 wherein said functional group-containing  
first-order modifier group ( $\gamma$ ) of said first  
-order modified polymer (A-3) comprises at  
least one functional group represented by a  
formula selected from the group consisting of  
the following formulae (a) to (m):

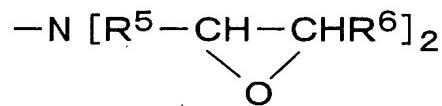
15



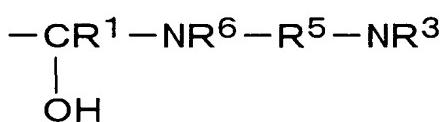
(e)



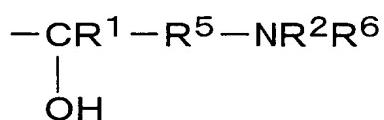
(f)



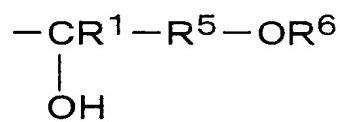
(g)



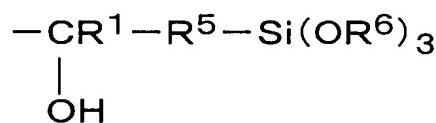
(h)



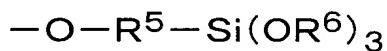
(i)



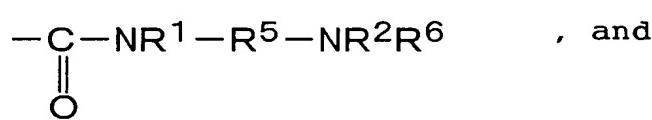
(j)

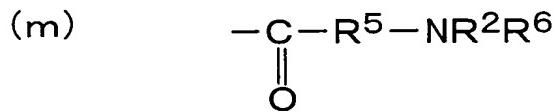


(k)



(l)





wherein, in the formulae (a) to (m):

- 5            N represents a nitrogen atom, Si represents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,
- 10          each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,
- 15          each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,
- 20          each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,
- 25          wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, in-

dependently has bonded thereto at least one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage other than a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

10        44. A styrene resin composition obtained by subjecting a raw material mixture to radical polymerization, said raw material mixture comprising:

15        2 to 30 parts by weight, relative to 100 parts by weight of the total of components (A-3) and (G), of (A-3) a first-order modified polymer comprising:

(β) a base polymer which is unhydrogenated or at least partially hydrogenated and which is at least one member selected from the group consisting of the following polymers (β-1) to (β-3):

20        (β-1) a conjugated diene polymer comprising conjugated diene monomer units,

(β-2) a copolymer comprising conjugated diene monomer units and vinyl aromatic hydrocarbon monomer units, said copolymer having no or at least one polymer block (H) of said vinyl

aromatic hydrocarbon monomer units, wherein  
said copolymer has a vinyl aromatic hydrocarbon  
block ratio of from 0 to less than 50 % by  
weight, said vinyl aromatic hydrocarbon block  
ratio being defined as the percent by weight of  
the vinyl aromatic hydrocarbon monomer units  
contained in said at least one polymer block  
(H) of said vinyl aromatic hydrocarbon monomer  
units, based on the total weight of vinyl aro-  
matic hydrocarbon monomer units contained in  
said copolymer as in the unhydrogenated state,  
and

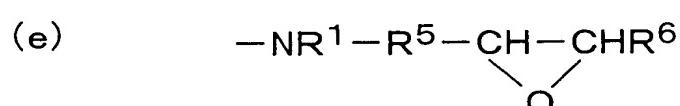
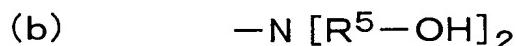
15                   (β-3) a vinyl aromatic hydrocarbon polymer  
comprising vinyl aromatic hydrocarbon monomer  
units, and

15                   (γ) a functional group-containing first-order  
modifier group bonded to said base polymer (β),  
98 to 70 parts by weight, relative to 100 parts by  
weight of the total of components (A-3) and (G), of (G)  
20                   a vinyl aromatic hydrocarbon monomer or a mixture of a  
vinyl aromatic hydrocarbon monomer and a comonomer co-  
polymerizable with said vinyl aromatic hydrocarbon  
monomer, and

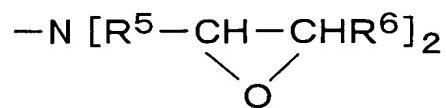
25                   0.01 to 20 parts by weight, relative to 100 parts  
by weight of the total of components (A-3) and (G), of

(C) a second-order modifier having a functional group which is reactive to said functional group of said first-order modifier group ( $\gamma$ ) of said first-order modified polymer (A-3), wherein said second-order modifier (C) is at least one member selected from the group consisting of a functional monomer and a functional oligomer,

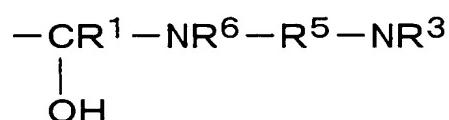
wherein said functional group-containing first-order modifier group ( $\gamma$ ) of said first-order modified polymer (A-3) comprises at least one functional group represented by a formula selected from the group consisting of the following formulae (a) to (m):



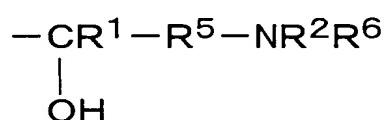
(f)



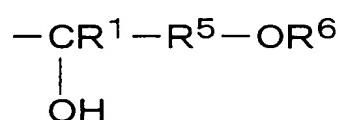
5 (g)



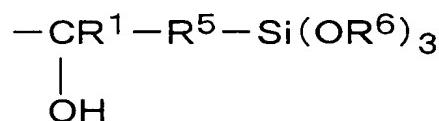
(h)



10 (i)

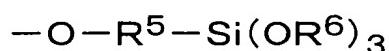


(j)

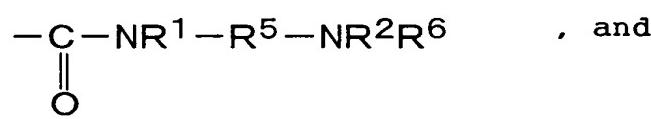


15

(k)

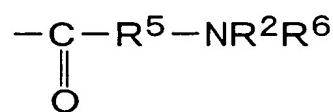


(l)



20

(m)



wherein, in the formulae (a) to (m):

25

N represents a nitrogen atom, Si repre-

sents a silicon atom, O represents an oxygen atom, C represents a carbon atom, and H represents a hydrogen atom,

each of R<sup>1</sup> to R<sup>4</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>24</sub> hydrocarbon group which optionally has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

each R<sup>5</sup> independently represents a C<sub>1</sub>-C<sub>48</sub> hydrocarbon group and optionally, independently has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C<sub>1</sub>-C<sub>24</sub> alkoxy silane group,

each R<sup>6</sup> independently represents a hydrogen atom or a C<sub>1</sub>-C<sub>8</sub> alkyl group,

wherein each of R<sup>1</sup> to R<sup>5</sup> optionally, independently has bonded thereto at least one atom selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and a silicon atom, said at least one atom being present in a linkage

other than a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

5       45. The styrene resin composition according to claim 44, wherein said raw material mixture further comprises 0.5 to 300 parts by weight, relative to 100 parts by weight of component (A-3), of (B) a reinforcing filler.

10      46. The styrene resin composition according to claim 45, wherein said reinforcing filler (B) is at least one member selected from the group consisting of a silica inorganic filler, a metal oxide, a metal hydroxide and carbon.